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MARKTON, AN OAT VARIETY IMMUNE FROM COVERED SMUT [1]

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INTRODUCTION

For a number of years it has been observed that most of the varieties of the Red Rustproof oat, *Avena byzantina* C. Koch (*A. sterilis* L.), show resistance to loose smut, *Ustilago avenae* (Per.) Jens., and covered smut, *Ustilago levis* (K. and S.) Magn. However, no satisfactory varieties of the common oat, *A. sativa* L., were known that were immune or highly resistant to these smuts. Reed [2] recently has stated that Black Mesdag and an unnamed European black oat, *A. sativa* L. var. *nigra*, showed complete immunity from the oat smuts in artificial-infection experiments during two consecutive years. Neither of these varieties is desirable, because of the black color of the kernel and the relatively low yielding power. The Markton oat described in this circular is the first variety of common oat with high yielding ability and fairly satisfactory kernel characters which has been found to show complete immunity from covered smut. It is believed that a brief statement regarding the history, description, smut resistance, and yielding power of this variety will be of interest to those concerned with oat improvement.

HISTORY

The lot of seed from which the Markton oat was later selected was obtained in 1904 by M. A. Carleton from the exhibit of Louis

[1] The limited results presented from Newell, S. Dak., Moccasin, Mont., and Dickinson, N. Dak., were obtained by the Office of Cereal Investigations, Bureau of Plant Industry, in cooperation with the Agricultural Experiment Stations of South Dakota, Montana, and North Dakota, respectively.

[2] G. M. Reed. Varietal resistance and susceptibility of oats to powdery mildew, crown rust, and smuts. Mo. Agr. Exp. Sta. Research Bul. 37, 41 p., illus. 1920.

Dreyfus & Co., at the Louisiana Purchase Exposition, held in St. Louis, Mo. The original source of the seed was recorded as Dedeagatch, Turkey. It was given Cereal Investigations (C. I.) No. 357 and distributed to several agricultural experiment stations, where the variety was grown for a few years and then discontinued. Its real value apparently was overlooked in these early experiments, from which few data are available.

With the beginning of the cooperative cereal experiments at the Sherman County Branch Station, Moro, Oreg., in 1910, a number of oat varieties were obtained from various sources for the establishment of a breeding nursery. Among those received from the Dickinson, N. Dak., substation was the unnamed variety, C. I. No. 357. It was grown in the nurseries at Moro in 1910 and 1911, two rod rows being devoted to it in 1911. Several head selections were made by H. J. C. Umberger, then superintendent, and the seed sown in head rows in 1912. Seed from the highest yielding head row was sown in four 8-rod nursery rows in 1913. When the oats were about ripe in 1913, a notation was made that the selection C. I. No. 357–1, since named Markton, looked promising. Its yield also was higher than that obtained from most of the other varieties in the experiments. A single twentieth-acre plat was sown in 1914, and it has been continued in the varietal experiments at Moro.

Its continued promising behavior at Moro, and later at Pullman, Wash., where its immunity from covered smut was discovered, created a demand for a name. At the suggestion of D. E. Stephens, who is responsible for the development of the selection, it was named "Carleton" in the spring of 1922, and has been distributed under that name to a limited extent in central Washington by the Waterville Branch Station and in Oregon by the Sherman County Branch Station. A brief notice regarding this oat, under the name "Carleton," appeared in the Official Record of the Department of Agriculture for May 16, 1923.[3] However, in order to make the naming conform to the rules of nomenclature of the American Society of Agronomy, it was renamed Markton and accessioned under Cereal Investigations No. 2053 in November, 1923.

DESCRIPTION

The Markton oat belongs to the common-oat group, *Avena sativa* L. It is an erect, short to midtall, midseason variety, with branching panicles. In some characters it is similar to the Green Russian variety. However, its very hairy culm nodes and larger panicle separate it distinctly from that variety. It also tillers more heavily than the Green Russian, and at the time of heading the whole plant is lighter green in color. The variety at this stage is outstandingly distinct in appearance and color, but at maturity it resembles Green Russian and similar sorts in general appearance. Its smut immunity will serve further to separate it from other similar varieties. The kernels of Markton are yellowish white, long, and slender, with a rather thin hull. The lower kernel of the spikelet usually carries a fine to coarse awn.

At the Washington Agricultural Experiment Station (Pullman), where Markton has been compared with Banner (Silvermine type),

[3] United States Department of Agriculture. Valuable variety of oats found. U. S. Dept. Agr., Offic. Rec., v. 2, no. 20, p. 4. 1923.

the best variety of oats for eastern Washington, the number of kernels in 5 grams is 193 for Banner and 178 for Markton. The proportion of hull to kernel was 28.4 per cent for Banner and 26.8 per cent for Markton. The bushel weights are practically identical. The Markton heads about seven days earlier than Banner but ripens at about the same time. It produces straw about 2 inches shorter than that of Banner. Spikelets of the Markton, Kherson, and Swedish Select varieties of oats are shown in Figure 1.

IMMUNITY FROM COVERED SMUT

The most important discovery concerning the Markton oat is its immunity from covered smut. A study made by the Office of Plant-Disease Survey, Bureau of Plant Industry, United States Department of Agriculture, in 1917, 1918, and 1919 showed the loss due to smuts of oats in the United States to exceed 50,000,000 bushels annually. The loss in Washington alone was about a third of a million bushels, most of which was due to covered smut.

FIG. 1.—From left to right, spikelets of Markton, Kherson, and Swedish Select oat varieties, respectively. (Natural size)

In an attempt to find some method of preventing this loss the State Agricultural Experiment Station at Pullman, Wash., began testing the standard varieties of oats in 1917 to determine their comparative resistance to covered smut. The method used was to blacken the seed with viable spores just before sowing, so as to insure maximum infection. At harvest time the records were taken as follows: All of the plants of a given row were pulled and separated into three piles, (1) plants that showed no smut, (2) plants in which all of the panicles were entirely smutted, and (3) plants which had both diseased and healthy panicles, recording each separately. From the data so obtained it is easy to figure the total loss due to the smut, and the result is comparable to the percentage obtained from a head count, but gives the additional information regarding the amount of smut produced on the partly smutted plants.

In these experiments it was found that all of the varieties of white and of black oats were more or less susceptible to smut. The Red Rustproof oat usually was resistant or immune.

In 1918 and 1919 the Washington station obtained many other varieties of oats from different parts of the United States for these experiments. Among those received in 1919 from the Sherman County Branch Station at Moro, Oreg., was the selection from C. I. No. 357, to which had been given the tentative number C. I. No.

357–1. This was grown with the other varieties during each of the five years from 1919 to 1923, inclusive, in a row of sufficient length to give fairly reliable results. A total of 582 plants has been under observation during the fluctuating conditions of five seasons, but no trace of covered smut has been found in this selection.

In the other varieties which are susceptible to the disease, infected plants were obtained in every experiment. In some varieties as high as 98 per cent of the heads were destroyed. The annual and average comparison between Banner and Markton in respect to smut resistance is shown in Table 1.

TABLE 1.—*Immunity of the Markton variety from covered smut as compared with infection in Banner oats at the Washington Agricultural Experiment Station, Pullman, Wash., during the 5-year period from 1919 to 1923, inclusive*

Variety	C. I. No.	Annual, total, and average results, showing number of plants and percentages of smut											
		1919		1920		1921		1922		1923		Total plants	Average smut
		Plants	Smut	Plants	Smut	Plants	Smut	Plants	Smut	Plants	Smut		
Markton	2053	155	0	115	0	50	0	92	0	170	0	582	0
Banner	1911	175	38	111	30	62	24	82	7	170	29	600	26

The data shown in Table 1 indicate definitely the immunity of Markton from covered smut. In these studies it was observed that the amount of infection in the Banner variety depends upon the amount of soil moisture at seeding time and the time of seeding, the higher moisture content and cooler weather favoring a greater development of smut.

The hulls of susceptible varieties offer considerable protection against smut. If the lemma is peeled off and the naked seeds are blackened with viable smut spores a much larger percentage of smut is obtained. In 1923 a row of Banner treated in this manner produced 84 per cent of smutted panicles. Markton treated in the same manner was smut free.

COMPARATIVE YIELDS

Comparable yields of the Markton oat are available from the experiment stations at Pullman and Waterville, Wash., Moro, Oreg., Newell, S. Dak., Moccasin, Mont., and Dickinson, N. Dak.

YIELDS AT PULLMAN

The Markton variety has been grown by the Washington Agricultural Experiment Station at Pullman in rod rows repeated three times in different parts of the cereal nursery during the 4-year period from 1920 to 1923, inclusive. Yields of the Markton as compared with those of the Banner (Silvermine type) are shown in Table 2.

It is recognized that experiments covering only four years and conducted on such small plats are not sufficient for final conclusions, but so far as the above figures indicate comparative yields Markton has outyielded Banner by an average of 2.5 bushels per acre.

In 1923 the Markton and Banner varieties were grown in duplicate fortieth-acre plats also and produced yields of 106.8 and 102.4 bushels, respectively, a difference of 4.4 bushels in favor of the Markton.

TABLE 2.—*Yields of the Markton and Banner varieties of oats grown at the Washington Agricultural Experiment Station, Pullman, Wash., during the 4-year period from 1920 to 1923, inclusive*

Variety	C. I. No.	Washington No.	Acre yields (bushels)				
			1920	1921	1922	1923	Average
Markton	2053	2088	96.3	61.1	40.9	122.4	80.2
Banner	1911	764	92.6	51.8	43.9	122.5	77.7

In anticipation that the Markton oat will prove superior for commercial purposes in subsequent experiments, the Washington station is increasing the seed of this variety and harvested 143 bushels from 1.36 acres in the summer of 1923.

YIELDS AT WATERVILLE

The Markton oat has been included in the varietal experiments since 1919 at the Waterville Branch Station, Waterville, Wash. Annual and average acre yields in bushels of the Markton, Abundance, Kherson, and Sixty-Day varieties for periods varying from three to five years are shown in Table 3.

TABLE 3.—*Yields of the Markton, Abundance, Kherson, and Sixty-Day varieties of oats grown at the Waterville Branch Station, Waterville, Wash., during three or more years of the 5-year period from 1919 to 1923, inclusive*

[Data presented by courtesy of the Waterville Branch Station]

Variety	C. I. No.	Acre yields (bushels)					
		1919	1920	1921	1922	1923	Average, 1920 to 1923
Markton	2053	27.0	22.5	55.2	40.5	33.1	37.8
Abundance	1192	----	18.7	59.0	39.5	31.3	37.1
Kherson	134	27.0	19.4	41.2	34.2	----	----
Sixty-Day	165	25.6	18.1	41.2	----	----	----

The data presented in Table 3 show that during the 4-year period from 1920 to 1923, inclusive, in which comparable data are available, the Markton has produced slightly the highest average yield at Waterville. It has been distributed to farmers from the Waterville Branch Station and is now the leading variety in that district. Markton has been preferred to other varieties because of its high bushel weight, early maturity, and high yielding power.

YIELDS AT MORO

As previously stated, Markton was first promoted from the nursery to plat experiments at the Sherman County Branch Station in 1914. The variety has been continued in the varietal experiments at Moro since that date in duplicate twentieth-acre plats.

Annual and average acre yields of the Markton, with dates of heading and ripening, compared with similar data from the best selections of Sixty-Day and Swedish Select grown in plat experiments at Moro during the 10-year period from 1914 to 1923, inclusive, are shown in Table 4.

TABLE 4.—*Yields and dates of heading and ripening of the Markton, Sixty-Day, and Swedish Select varieties of oats grown at the Sherman County Branch Station, Moro, Oreg., during the 10-year period from 1914 to 1923, inclusive*

[In cooperation with the Oregon Agricultural Experiment Station]

Year	Variety								
	Markton, C. I. No. 2053			Sixty-Day, C. I. No. 165–1			Swedish Select, C. I. No. 134–1		
	Date headed	Date ripe	Acre yields	Date headed	Date ripe	Acre yields	Date headed	Date ripe	Acre yields
			Bu.			*Bu.*			*Bu.*
1914	June 20	July 12	45.0	June 15	July 10	65.6	June 24	July 14	37.9
1915	June 18	July 14	49.2	June 10	July 7	57.2	June 22	July 19	52.0
1916	July 3	Aug. 7	102.8	June 25	July 30	80.3	July 5	Aug. 7	104.7
1917	June 24	July 16	35.3	June 21	July 12	37.2	July 2	July 22	26.6
1918	June 25	July 12	30.8	June 23	July 10	36.9	June 30	July 15	34.1
1919	June 20	July 14	61.6	June 18	July 11	52.2	June 25	July 18	50.4
1920	July 2	July 20	44.1	June 28	July 16	35.9	July 1	July 24	37.5
1921	June 23	July 18	46.7	June 20	July 16	45.6	June 30	July 19	36.0
1922	June 25	July 10	32.5	June 23	July 8	23.5	June 29	July 16	25.7
1923	June 25	July 25	86.3	June 22	July 22	80.3	July 2	Aug. 2	76.3
Average	June 25	July 18	53.4	June 21	July 14	51.5	June 29	July 22	48.1

The Sixty-Day and Swedish Select varieties have been grown since 1913 in the varietal experiments at Moro, but comparable data are available for the Markton only during the 10 years from 1914 to 1923, inclusive. In this period, as shown in Table 4, the average yields of the Markton, Sixty-Day, and Swedish Select have been 53.4, 51.5, and 48.1 bushels, respectively. The Markton, therefore, has exceeded the selection of Sixty-Day by only 1.9 bushels.

A statistical study [4] of this difference indicates that the odds are only 4.5 to 1 in favor of Markton, actually a higher yielding variety than the selection of Sixty-Day. Odds as small as this are of little significance. The odds are 293.1 to 1 in favor of Markton when compared in yield with Swedish Select.

In date of heading at Moro the Markton has been about four days later than Sixty-Day and about five days earlier than Swedish Select. There is about the same relation in the date of ripening.

The Markton oat has not yet become commercially important in Oregon. Its distribution thus far has been largely limited to experiment stations. One farmer in Sherman County, Oreg., grew fields of Markton and of Sixty-Day in 1922 and 1923 and reported the yield of the two to be about equal in 1922 and that Markton produced a higher yield in 1923. At the Sherman County Branch Station in 1923 a $1\frac{1}{4}$-acre plat of Markton produced 112 bushels, or at the rate of 89.6 bushels per acre. Most farmers in eastern Oregon who have grown the Sixty-Day variety object to its small kernels and light bushel weight. The Markton is superior to the Sixty-Day in these respects, though the kernels of the Markton ordinarily are not as large and plump as those of the Swedish Select and other midseason varieties.

YIELDS AT NEWELL

The original oat, C. I. No. 357, from which Markton was selected, was included in the cooperative nursery experiments for several years at the Belle Fourche Experiment Farm, Newell, S. Dak.

[4] Anonymous. The probable error of a mean, by Student. Biometrica, v. 6, p. 1–25, 1908.

In Department of Agriculture Bulletin No. 1039[5] the following statement is made regarding this oat:

Many varieties also were grown in nursery rows. Of these, an unnamed variety, designated as C. I. No. 357, outyielded all other varieties and strains during a period of several years. This variety was being increased for plat experiments in 1918, but was never grown in plats at Newell.

The average data on which the above statement is based are shown in Table 5 in comparison with those from four other varieties or selections. The high yielding ability of the original strain of this oat under dry-land conditions at Newell is evident.

TABLE 5.—*Average yields of the original unselected oat C. I. No. 357, the Beseler, and the three highest yielding selections of the Kherson and Sixty-Day varieties grown in 60-foot nursery rows under dry-land conditions at the Belle Fourche Experiment Farm, Newell, S. Dak., in the 6-year period from 1912 to 1917, inclusive*

[Data obtained in cooperation with the South Dakota Agricultural Experiment Station]

Variety	C. I. No.	Acre yields (bushels)[1]
C. I. No. 357 (unselected)	357	35.7
Beseler[2]	595	34.0
Kherson selection	459–663	32.8
Sixty-Day selection	165–566	32.8
Do	165–631	32.8

[1] Data from annual reports of the cooperative cereal investigations on the Belle Fourche Experiment Farm, filed in the Office of Cereal Investigations.
[2] A midseason white oat, similar to Swedish Select.

YIELDS AT MOCCASIN

In the spring of 1921 Markton and several other new varieties of oats were sent to the Judith Basin substation, Moccasin, Mont., for sowing in nursery rows in cooperation with the Montana Agricultural Experiment Station. The yields of Markton and of the three highest yielding of the other new varieties, grown in duplicate 15-foot rows from 1921 to 1923, inclusive, are shown in Table 6.

TABLE 6.—*Yields of Markton and three other oat varieties grown in duplicate 15-foot rows at the Judith Basin substation, Moccasin, Mont.,*[1] *during the 3-year period from 1921 to 1923, inclusive*

[Data obtained in cooperation with the Montana Agricultural Experiment Station]

Variety	C. I. No.	Acre yields (bushels)			
		1921	1922	1923	Average
Markton	357–1	77.3	55.1	75.4	69.3
Alexander	1592	70.6	44.9	75.3	63.6
College Success	1588	65.9	49.4	75.3	63.5
States Pride (Wisconsin No. 7)	1154	54.8	52.9	47.3	51.7

[1] Data from annual reports of the cooperative cereal investigations at the Judith Basin substation, filed in the Office of Cereal Investigations.

The few data shown in Table 6 are decidedly in favor of the Markton variety. It exceeded in yield the pure-line varieties Alexander and College Success, from the Michigan Agricultural Experiment Station, by about 5.8 bushels per acre. States Pride (Wisconsin

[5] J. H. Martin. Experiments with cereals on the Belle Fourche Experiment Farm, Newell, S. Dak. U. S. Dept. Agr. Bul. 1039, p. 31. 1922.

No. 7), a selection from Kherson, a variety that is well adapted to central Montana, has fallen nearly 18 bushels in yield below that of the Markton. While these are new strains in that section, the Markton also is new, and therefore the results should be comparable.

YIELDS AT DICKINSON

The original oat, C. I. No. 357, was grown at the Dickinson (N. Dak.) substation, in cooperation with the North Dakota Agricultural Experiment Station, for several years immediately after its introduction. However, no yield data have been reported from these early experiments. Markton, C. I. No. 2053, was grown in duplicate rod rows at Dickinson in 1921 and produced an acre yield of 4 bushels, as compared with 10.6 bushels for Early Mountain, the check variety. Similar rows of Empire and Comewell, new strains of midseason white oats, produced yields of 17.7 and 15.5 bushels, respectively. Markton was not grown at Dickinson in 1922. In 1923 it was included in the varietal experiments in plats at that substation and produced a yield of 48.8 bushels, as compared with 60.7 bushels from Golden Rain, the highest yielding of the varieties with branching panicles. These somewhat indefinite data indicate that the Markton variety is of no particular promise under conditions obtaining in western North Dakota.

VALUE FOR BREEDING SMUT-IMMUNE VARIETIES

If for any reason Markton does not prove superior for commercial purposes, it still should be a valuable variety for hybridizing with other varieties of common oats. If by this process smut-immune strains of important commercial varieties, such as Silvermine, Swedish Select, Kherson, Green Russian, etc., can be developed, substantial progress will have been made in reducing the loss caused to the oat crop by smuts.

SUMMARY

Markton, C. I. No. 2053, a selection from an unnamed variety of oats, C. I. No. 357, made at the Sherman County Branch Station, Moro, Oreg., in 1911, recently has been found by the Washington Agricultural Experiment Station at Pullman, Wash., to be immune from covered smut.

The original unnamed oat, C. I. No. 357, was obtained at the Louisiana Purchase Exposition in 1904 from a sample said to have come from Dedeagatch, Turkey.

Markton is the first variety of common oat with yellowish white kernels and high yielding power which is immune from covered smut, so far as known.

Markton has been the highest yielding variety at Moro, Oreg., during the 10-year period from 1914 to 1923, inclusive, and at Pullman and Waterville, Wash., in the 4-year and 5-year periods, respectively, in which it has been included in the experiments.

Excellent yields have been obtained from the Markton at Moccasin, Mont., and from the original unnamed variety, C. I. No. 357, at Newell, S. Dak.

If Markton does not prove superior for commercial purposes, it should still be a most valuable variety for use in crossing to produce other smut-immune varieties.

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